Design of an Ultrasonic Hyperthermia Unit for Breast Cancer Treatment

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The use of breast-conserving therapy in patients with breast cancer containing an extensive intra-ductal component of tumor is associated with increased rates of local failure. Intraductal carcinoma is characterized by proliferation of cancer cells within breast ducts typically showing central necrosis, which may correspond to hypoxic regions. Therefore patients may benefit from a combined approach using hyperthermia and radiation therapy. A dedicated ultrasound breast treatment unit has been designed based on the transducer-acoustic and bio-heat transfer models.

With the patient in prone position, the breast will be immersed in water and surrounded by a 25 cm diameter cylindrical transducer array. The cylinder consists of eight rings, each ring having an even number of transducers with 8 transducers at the apex increasing to 48 at the base of the breast. The transducers are mounted on the periphery of each ring. Every second transducer emits a different but broad frequency band; 1.5-2.5 MHz for low frequency and 3.5-4.5 MHz for high. Extensive computer simulations show this applicator will be able to treat from a quadrant of the breast to the whole breast to between 41.5 °C and 44 °C. The combination of low and high frequency ultrasound permits excellent control of the energy deposition and resulting temperature distribution for perfusion range of 0-8 ml/ (min **.** 100g). The profile of the breast will be determined by the ultrasonic echoes. Temperatures and the thermal perfusion properties will be monitored by the minimally invasive multi-sensor probes. Data provided by these probes will be used to change the heating patterns with the corresponding temperature fields displayed in real time.